Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	
An Inquiry into the Commission's	)	
Policies and Rules Regarding AM	)	MM Docket No. 93-177
Radio Service Directional Antenna	)	RM-7594
Performance Verification	)	

Comments of Potomac Instruments, inc.

Potomac Instruments, inc., ("**PI**") hereby submits its comments in response to the above referenced Notice of Proposed Rule Making ("NPRM") adopted May 28, 1999 and released June 11, 1999.

PI and its predecessors have, for more than fifty years, been actively engaged in the design, development and manufacture of precision test and measurement equipment intended specifically for the purpose of quantifying various technical parameters pertaining to terrestrial radio and television broadcast signals. Perhaps our greatest contribution to this proceeding is the perspective that this firm offers as the industry's predominant supplier of AM Field Strength Meters and AM Directional Antenna Monitors. Because of the unique nature and long life of these instruments we are, more often than not, able to continuously observe and re-evaluate the equipment performance and the care that it receives as it passes through our shop for service and calibration during its lifetime. As can be imagined, these instruments are placed in service in all sorts of environmental conditions. A number have been returned for calibration after being subjected to prolonged submersion in very dirty water or subsequent to having served as habitat for rodents or snakes. We have serviced instruments that have survived being hit by a fast moving truck (literally), dropped from towers, struck by lightning, burned by fire, and shot by rifle. Like others who comment on this proceeding we expect that some of our comments will be judged to be self-serving. While we have worked to remain objective throughout, we are unable to ignore lessons learned regarding the use and abuse of measurement equipment by station personnel and our comments are likely to reflect this "real world" perspective.

I. Introduction

1. Through the cooperative efforts of broadcasters, equipment manufacturers, the broadcast engineering community, and the FCC, the U.S. AM broadcast service has matured to a level of 4,793

stations generating some $25 billion in annual revenues. Like the word "ripen," the word "mature" has multiple connotations. Because of ever increasing competitive pressures for audience, the very existence of this service depends upon absolute adherence, by the industry, to the Commission's stated policy objectives of controlling interference and assuring adequate community coverage. This medium faces interference challenges that are not encountered by other broadcast services because of naturally occurring spectral phenomena, because of properties inherent to the modulation scheme, and because of the sheer number of stations sharing the spectrum. In contemplation of changes to the regulations that have guided the development of this service for the past half-century, it would be wise to recall the first tenet of the physician: "First, do no harm."

2. To oppose any action that would simultaneously improve the product, reduce overhead, and reduce government regulation would be unconscionable. No one could or should object to such a premise unless, of course, the process proved to be injurious to an innocent party or class. **PI** believes that Method of Moment (MOM) computer modeling , when properly applied, has been proven to be of enormous benefit in the design and tuning phases of the AM directional antenna array ("DA") project. Accordingly, we support the position that the Commission's rules and procedures should be amended, to the extent practicable, to accommodate the efficiencies created by this technology in the commissioning of, or modification of, a DA. Further, we commend the Mass Media Bureau for the issuance of this proceeding, its specific solicitation of comments, its apparent willingness to review and amend current policy procedures that do not compromise its regulatory responsibilities, and for the thoroughness of its proposals.

II. The MOM paradigm, situational awareness, and the law of untended consequences

3. Advocates for the elimination of proofs of performance provide convincing arguments and anecdotal data that tend to indict AM field strength measurements which are predicated solely upon the determination of the magnitude of the magnetic ("H") field component of the propagated wave. They correctly point out that the indication provided by conventional field strength meters that employ a shielded loop antenna is a scalar quantity and, therefore, it differs from the actual electric ("E") field in a manner which is similar to the way speed differs from velocity. This E and H field relationship has been recognized for many years and continues to be studied to this day. In "near-field" conditions and in situations where ground conductivity varies greatly, measured H field strength can differ from computed E field strength by several dB. Large metal structures, lakes, wetlands, rivers, community development, and seasonal effects can become significant contributors to anomalous AM field strength measurements. However, as evidenced by the fact that a majority of the existing DA's were constructed and "proofed"

prior to the introduction of MOM, in most far fields the H field measurement uncertainties are definitely tolerable or, if in error, are at least repeatable. (Granted, in many cases, proof data points have been "eyeballed" and "engineering judgement" was exercised to make the measured data conform to the FCC's standard pattern. But, the raw field strength data is provided for all interested parties to see and evaluate.) If this were not the case, FCC field inspectors would not have been able to verify monitor point values for the past several decades. What is the definition of "interfering signal"? Is it not the purpose of the field strength meter to verify, with repeatable accuracy, the ground wave component of the terrestrial broadcast signal that a listener's radio would "see" if that radio were immersed in the same R.F. field at the same point in space and time – regardless of the complexity of the E and H field relationship?

4. Absent independently verifiable field strength benchmark data, what means can be used to ascertain that the initial parameters selected for the computer model were, indeed, correct? Who would benefit from a system in which interference issues would be resolved through civil litigation or in which an administrative law judge would be forced to decide which computer model is correct? In the event that anyone should choose to reject the argument that incorrect data can, and will, be used for computer modeling, we would remind them of the very recent loss of NASA's Mars Climate Orbiter spacecraft. In this calamitous example of incorrect computer modeling assumptions, the flight controller's software anticipated that the thruster units would be expressed in metric units when, in fact, the manufacturer's thruster calibration table had been tabulated in English units. Whereupon pundits were quick to paraphrase an ancient axiom by saying "An ounce of prevention is worth 0.4536 kilograms of cure".

5. The concept of tuning DA's without supporting field strength measurements is, to the empiricist, counterintuitive. It is reminiscent of the prevailing philosophy of certain professional educators in the U.S. public school systems in the early 1960's. In that scenario, the proponents of change suggested that then current teaching methods were archaic, that measurement techniques such as regents exams were inaccurate, and that only properly trained educators using modern methodology could quantify and evaluate the individual capabilities and academic achievements of a given student. The metaphor is imperfect. However, it does evoke sufficient retrospective to bring into question the long-term effects of adopting a standard operating procedure that could possibly jeopardize the viability of an entire broadcast service. Is it possible that, unlike today's AM directional engineering community, DA modeling practitioners of the future might be influenced by differing sets of economic constraints, political pressures and engineering practices?

6. **PI** endorses the consensus of the National Association of Broadcasters ("NAB") sponsored MM Docket 93-177 NPRM Ad Hoc Meeting of 13 October 1999 in which it was agreed that

the Commission would be jointly petitioned to extend the comment period for article II of this proceeding only. At that meeting, it was suggested and agreed that, given the opportunity to engage in further dialog, the group might be able to generate specific recommendations that would reconcile unresolved issues related to MOM methodology and the perceived need for DA tuning verification by physical measurement. **PI** has agreed to participate in this effort if the issue can be addressed by Notice of Further Proposed Rulemaking or other suitable regulatory means.

III. Directional Antenna Full and Partial Proofs of Performance

7. **PI** concurs with the premise that Full Proofs of Performance provide a uniform and verifiable means of constructing important baseline reference data against which all future data can, and should be, analyzed. Further, we accept the apparent consensus of the DA engineering community which would seem to indicate that the number of required measurements in a given proof can be reduced to a level below current requirements without compromising AM broadcast interference standards, and the enforcement thereof. This firm's area of expertise relates to instrumentation methodology for data collection and not to the data analysis process. Accordingly, in this matter, we defer to those who are better qualified to specify the requisite number of radials to be measured, the appropriate distance from station for measurements, and the adequacy of the number of data points required, per radial, to properly define the pattern of the antenna array.

8. Directional antenna arrays, once tuned and Proofed, are not steady state appliances. Their physical parameters will, and do, change with time, climatic conditions, meteorological incidents, and other external influences. Because of the real-world dynamics of these arrays, current FCC rules provide a vehicle for antenna pattern re-certification involving fewer measurements than those deemed necessary for the full proof of performance. The partial proof is intended to accommodate repairs, extensive array maintenance or component modification. Once again, there seems to be a consensus among the DA engineering community that the number of measurements required in a partial proof can be reduced to a level below current requirements. **PI**, therefore, concurs that eight measurement points per radial will provide adequate pattern verification without compromising the integrity of the partial proof of performance process

9. **PI** concurs with the Commission's proposal to eliminate the requirement to conduct certain partial proofs that might, otherwise, be triggered by the replacement or modification of tower mounted sampling system components. If the mounting locations of the new components exactly match those of the old components, "before" and "after" monitor point measurements are in agreement, and all

“before” and “after“antenna monitor indications are within legal tolerances, a partial proof is, within reasonable certainty, superfluous.

10. In recognition of the realities of current electronic data interchange technology, **PI** concurs with the Commission’s proposal to standardize the compilation format for field strength measurement data that is to be submitted for review and action. The proposed format would include the following measurement parameters: (1) the date(s) of the measurement, (2) the azimuth of the radial being measured, (3) distance from the measurement point to the center of the antenna array, (4) measured field strength value, and (possibly) (5) the time of day.

11. We foresee an increasing reliance upon Global Positioning Satellite (“GPS”) technology for time, distance, and bearing information. Inexpensive, readily available, hand-held GPS receivers currently provide direct readout of bearing (reciprocal of radial azimuth) and distance to station, thereby aiding in manual data collection today. We believe that any new standardized data format should be capable of accommodating direct importation of certain components of standardized National Maritime Electronics Association (“NMEA”) GPS data messages. If this capability is included, then current data collection techniques could be seamlessly merged with future technology which will likely derive data directly from the GPS receiver. Accordingly, **PI** recommends the following format structure:

Field	**Description**
Dd/mm/yyyy	Date (day, month, year)
hhmmss.ss	UTC time in hours, minutes, seconds
ddmm.mmmmm	Latitude in degrees, minutes, and decimal minutes
ddmm.mmmmm	Longitude in degrees, minutes, and decimal minutes
ddd.d	Azimuth in degrees
mmm.mmm	Distance in kilometers
vv.vvvv	Field Strength in volts per meter

12. We understand that, if the suggested format is adopted, conversions will be required when transitioning between current U.S. Geological Survey (“USGS”) maps whose coordinates are expressed in degrees, minutes, and seconds and GPS coordinates that are expressed in degrees, minutes, and tenths of minutes. We also understand that GPS Standard Positioning Service (“SPS”) currently limits horizontal position accuracy to 100 meters because of Department of Defense (“DOD”) imposed Selective

Availability ("SA") data degradation. However, we believe that GPS notation is the preferred format for the following reasons: (1) DOD has announced its future intent to disable SA in the GPS satellite constellation except in the case of national emergency. (2) Virtually all of the field strength measurement data supplied to the Commission in support of a filing will be gleaned from user prepared spreadsheet or database software, either of which readily accommodates an automated means for coordinate conversion. (3) Commercial availability of GPS compatible map overlay software is exploding thereby offering the potential for greatly improved DA pattern analytical tools for industry and regulator alike.

A. Monitoring Points

13. Monitoring points serve as DA pattern equivalents of boundary landmarks for real estate parcels. They provide verifiable reference points that are readily accessible to any interested party. Station personnel are charged with the responsibility of knowing the physical locations of monitoring points and also with being able to relate measured field strength values, at those points, to antenna array performance. Monitor points provide a readily available vehicle for cross correlation of anomalous antenna monitor and/or base current meter readings. Station Chief Operators, consulting engineers, contract engineers, and FCC field inspectors have, historically, referred to monitor point measurements as a primary source of confirmation whenever array performance is called into question. **PI** believes that the accepted practice of ratioing measured directional field strength values to measured nondirectional field strength values minimizes monitor point measurement uncertainties induced by diurnal effects, weather conditions and/or seasonal variations. Accordingly, we do not believe that DA monitor point requirements should be eliminated.

14. **PI** does not believe that monitoring point coordinate identification via differential GPS locator techniques will provide adequate monitoring point location definition. Fifty years of anecdotal information tells us that some monitor point measurements, especially those at pattern null locations, must be made with the measurer's feet planted at a specific spot. We are told that, in some instances, field strength measurements can be out-of-tolerance if the point of measurement is varied even slightly. Navigational beacon based differential GPS accuracy specifications and our own field tests have proven to us that conventional differential GPS techniques do not provide adequate horizontal resolution for locating critical monitor points. Accordingly, we recommend that rules requiring precise descriptions of DA monitoring points be retained.

IV. AM Station Equipment & Measurements

A. Base Current Ammeters

15. Base current ammeters provide the first point of collaboration in the event of anomalous antenna monitor indications. When our firm receives a service call from a station technician who reports that the station's antenna monitor indications are "bananas", our personnel are trained to first ask if the base current readings and monitoring point readings are normal. Thus, the confirmation of, or ruling out of, anomalous base current information provides valuable diagnostic information when attempting to determine if the pattern has actually shifted or if the antenna monitor and/or the sampling system are suspect. Therefore, from our perspective, the role of base current meters is to provide secondary internal instrumentation in the event that the primary internal indicators fail or are removed for service. In the event that base current meters are deemed unnecessary as a result of this NPRM, **PI** hereby urges the Commission to revisit the matter of mandating antenna monitor re-calibration at biannual intervals.

B. Antenna Monitors

16. Section 73.69(a) of the FCC Rules stipulates that an Antenna Monitor is to be authorized on an individual basis when the Station Authorization sets specific tolerances for current ratio and phase. Presumably this would be done when authorized tolerances are tighter than the $\pm$5% for ratio and $\pm 3^\circ$ for phase as set forth in Sec.73.62. Such a monitor has been generally referred to as a precision monitor while the Sec.73.14 definition of a "Critical directional antenna" referred to a "high precision monitor".

17. It is unfortunate that our 93-177 Notice of Inquiry ("NOI") comments were misinterpreted by the Commission. **PI** <u>does not believe</u> that the elimination of 47 C.F.R § 73.53 would enhance the development of new and less expensive antenna monitor systems. This is simply a matter of economics. The total market universe for these instruments is fewer than two thousand stations. Because each existing station now owns a Type Approved antenna monitor (which can last for well in excess of 30 years), and very few new stations are being built, the market for new monitors is, almost exclusively, a replacement market. Therefore, the R&D return on investment for new antenna monitor designs must be amortized over decades instead of months or years. Such an action would not, in our opinion, trigger a rush to 'build a better mousetrap". In our NOI comments of 1993 we were soliciting government and industry dialog regarding an alternative means for establishing and updating antenna monitor technical standards that would neither restrict future technical advancement nor necessitate FCC Rule changes.

18. Although we are in complete accord with the Commission's desire to streamline its regulations, we do not believe that the elimination of minimum technical performance standards for Antenna Monitors from its rules is well advised. Quite to the contrary, we believe that the elimination of said minimum standards would send an incorrect signal to the licensee that the Commission is relaxing its

perseverance requirements regarding DA array monitoring through the process of deregulation. The benefit of 47 C.F.R § 73.53, or its equivalent, is twofold. First, it establishes minimum requirements for demonstrable accuracy, reliability, and repeatability over specified environmental conditions and time periods for *the* critical monitoring device of directional antenna arrays. Second, it provides the basis of authority that a station Chief Operator or Contract Engineer needs to present to station management in order to have the station's Antenna Monitor serviced and/or certified in the event of a catastrophic event, or an apparent out-of-tolerance array condition. Because of our continuing exposure to the realities of the day-to-day antenna array monitoring practices of various stations, **PI** firmly believes that the existence of lawful minimum operating specifications for Antenna Monitors is not only good engineering practice, it is also good regulatory practice. (Our reading of the changes, as proposed in this NPRM, leads us to the conclusion that obsolete antenna monitors, which could not meet type approval specifications developed thirty years ago, might, lawfully, be resurrected and placed in service - if retrofitted with $3\frac{1}{2}$ digit digital displays.) Accordingly, **PI** recommends that the existing technical requirements of 47 C.F.R § 73.53; [(a), (b)-(b9), and (b11)-(b12)(viii)] be retained as minimum antenna monitor requirements - provided that the only alternative is to eliminate them.

19. The concept of using voltage sampling devices in lieu of current sampling devices does not present any foreseeable problems to monitoring antenna arrays with existing type approved antenna monitors provided that the sample voltage levels remain within the specified tolerances of the antenna monitor in use. **PI** understands that voltage samples would, in many instances, better accommodate computer modeled parameters and, thus, would provide a more suitable "internal" measurement platform for tuning and monitoring modeled antenna arrays.

20. A universal voltage sampling device would need to be capable of residing at the base of a tower under extreme environmental conditions while routinely accommodating voltage peaks that are consistent with 50,000 watts or just a few watts - plus lightning transients. Such a sampling device would also have to exhibit circuit-loading characteristics that would not alter tower impedance and, of course, would not introduce errors in sampled voltage or phase over a frequency range from 535 kHz to 1.7 MHz. Perhaps such a device already exists. If it does not, the engineering challenges associated with the design and fabrication of voltage sampling elements should not be minimized.

V. Critical Arrays

A. Antenna Monitors for Critical Arrays

1. PMA-19 System

21. In practice, for the past 20-odd years the monitor used in nearly all "critical" arrays has been the Potomac Instruments' PM-19 System. With the PM-19, greater precision in ratio measurement is obtained through the use of a so-called "deviation" circuit in which the deviation of ratio from a preset value is measured independent of modulation effects. Because of this, specifying a "precision monitor" has, generally, been interpreted as meaning that a monitor using the deviation circuit for ratio monitoring is required.

22. The PM-19 Precision Antenna Monitor System consists of the standard **PI** type approved antenna monitor, model AM-19 or AM-19D (digital), and the Precision Monitor Adapter, model PMA-19, which connects to the AM-19. The AM-19 provides the tower and pattern selection functions and the circuitry as well as the controls associated with the phase and (conventional) current ratio measurements. The PMA-19 provides the circuitry and controls associated with current deviation measurements, and includes a highly accurate $4\frac{1}{2}$ digit voltmeter.

23. The "precision" designation of the PM-19 System stems from the ratiometric (ratio as in proportional + metric as in the science of metering) capabilities of its Current Deviation circuitry. Scientists for millennia have employed ratiometric measurement devices in the form of Equal-Arm balances to compare precisely the mass of an unknown quantity to the mass of a known quantity with great accuracy. This same principle is routinely applied throughout the world of electronic instrumentation in the form of "bridging" devices. Passive bridges and their electronic equivalents are employed as a means to "cancel out" measurement uncertainties due to circuit component tolerances and/or temperature changes and other detrimental environmental effects.

24. The current deviation circuit of the PM-19 consists of two detectors, one connected to the reference tower sampling line, the other connected (through relays) to a selected tower sampling line, with the detector outputs connected <u>differentially</u> to the digital voltmeter. Attenuators are provided to initially normalize the level from each sampling line for a detector DC output of 1.000 volts. The DVM decimal point is moved two places to the right, thus resulting in a DEVIATION indication of 000.0± the percent deviation of the selected tower current ratio with respect to the nominal ratio for the tower.

25. The current deviation measurement is truly differential in that the reference and selected tower signals are simultaneously and continuously detected over each modulation cycle and applied to the differential input of the DVM. Consequently, the measurement is independent of transmitter output level, carrier shift, and modulation effects are suppressed. Assuming that the impedance and bandwidth of each

tower are reasonably consistent over the transmitted spectrum, current ratio changes as low as 0.1% can be resolved without removing modulation.

26. In a conventional antenna monitor such as the AM-19 Series (analog or digital display) the tower current RATIO is indicated with respect to the reference tower current, either as a percent or as a proper fraction. On the other hand, the PMA-19 deviation method provides a reading of the tower current ratio error in percent deviation from the nominal ratio assigned to the tower, which is the basis of the tolerance limits specified in the F.C.C. instrument of authorization for critical directional arrays

27. The following example will clarify the difference in the two measurement methods.

Example:

Nominal Conditions at Licensed Values				
	TOWER CURRENT	AM-19D CURRENT RATIO	PMA-19 DEVIATION	1900 SERIES CURRENT RATIO
Tower #1 (Ref.)	2.00 Amps	100.0 %	000.0 %	1.000
Tower #2	1.00 Amp	50.0 %	000.0 %	.500

Actual Conditions (array tuning has drifted)				
	TOWER CURRENT	AM-19D CURRENT RATIO	PMA-19 DEVIATION	1900 SERIES CURRENT RATIO
Tower #1 (Ref.)	2.11 Amps	100.0 %	000.0 %	1.000
Tower #2	.95 Amp	45.0 %	-010.0 %	.450

Note that the deviation of the Tower 2 / Tower 1 ratio from the nominal ratio is:

$$\left(\frac{.450-.500}{.500}\right)*100=-10.0\%$$

Which is equal to the PM-19 DEVIATION indication. On the other hand, the difference in the conventional monitor readings is

$$(45\%-50\%)=5\%$$

or

$$(.450-.500)=.05$$

which must be mathematically adjusted (by dividing by the nominal ratio) to determine the actual deviation of the tower #2 ratio. Note further that, for low ratios, the discrepancy between the RATIO difference and the DEVIATION increases significantly, for example, for a ratio of 20% (0.20), the two measurements differ by a factor of 5.

28. For a standard array, with a specified current ratio tolerance of 5%, the ratio reading limits are usually calculated, and posted and/or listed on the station log. However, for critical arrays, when very close tolerances are specified, a direct reading of tower ratio deviation can be a significant factor in maintaining proper operation.

29. The short and long term repeatability of the PMA-19 DEVIATION readings are dependent only on the stability (not the component tolerance) of a bank of passive attenuators (one attenuator for each tower, for each pattern). All variations attributable to the electronic circuitry, including the amplifiers, detectors, and DVM, are cancelled (adjusted-out) in the reading procedure. The attenuators are constructed of highly stable deposited film resistors, MIL type RN70 with a “C” temperature characteristic. The attenuator vernier adjustment has a temperature coefficient of 50 PPM/°C.

30. The PMA-19 also includes provisions for performing a DC ratiometric measurement on each attenuator. This scheme, which uses the $4\frac{1}{2}$ digit DVM, allows the ratio of attenuator output voltage to input voltage to be read to a resolution of .01%, referenced to 1 (or 0 dB). Again, the repeatability of this measurement is independent of the DVM full scale accuracy. Attenuator tests are normally performed as a calibration check or when an attenuator setting is questioned.

31. Interfering signals are known to cause errors in current ratio measurements. Assuming a linear averaging detector (the optimum characteristic to minimize modulation effects), an undesired signal 14 dB below the signal being measured will cause a 1% error in the detector output. The PM-19 includes a pair of bandpass filters (actually tuned amplifiers), one ahead of the reference tower detector, the other ahead of the selected tower detector. The filters are factory tuned to the station frequency, and carefully matched over the passband to equalize the effects upon modulation components.

32. As indicated above, the PMA-19 includes a $4\frac{1}{2}$ digit DVM (1.9999 V full scale with the decimal point moved 2 places to the right). In addition to displaying the DEVIATION readings, advantage is taken of the precision voltmeter to display the PHASE and RATIO (percent of reference tower current) voltages derived from the AM-19 or AM-19D. Normally the least significant (right most) digit is

blanked (all segments off) for the PHASE, RATIO, and DEVIATION readings, since these parameters are not significant to the hundredths place. However, the blanked digit eliminates the ±1 digit ambiguity associated with $3\frac{1}{2}$ digit voltmeters - this is an important feature when maintaining very close array tolerances. Furthermore, all $4\frac{1}{2}$ digits are utilized when calibrating the DVM and, as noted above, when performing the ratiometric attenuator calibration.

2. 1900 Series Antenna Monitors

33. Advances in integrated circuit technology have made it possible to design circuits that measure current sample ratio directly while eliminating reading fluctuations resulting from high levels of monophonic and stereophonic modulation. PI's newest antenna monitor (1900 Series) also incorporates a ratiometric technique that simultaneously compares the inputs of the reference tower and non-reference tower(s) thus canceling imbalance caused by modulation effects and carrier shift. This technology enables the stability and repeatability of the 1900 Series antenna monitor to depend primarily upon the stability of passive components only, thus retaining another of the virtues of the PMA-19 deviation circuit. Similarly, the type of phase-detection circuit used in the 1900 Series Antenna Monitors has been found to be adequate for "precision" applications. Unlike the PM-19, however, the 1900 Series Monitors were designed to provide automatic sensing of the sign of the measured phase angle. This feature (critical when measured phase angles approach 0º or 180º) provides the licensee with much improved monitoring capabilities in a real world situation where the typical DA station is being operated via remote control and out-of-tolerance conditions are detected and flagged by automatic scanning circuitry.

34. The most crucial function of the antenna monitor is its ability to resolve and display, with repeatable accuracy and long term stability, deviations of directional antenna current ratios and relative phases from licensed values. In "critical array" applications demands for measurement certainty and stability are magnified. Critical array tolerances require antenna monitor performance which virtually guarantees that any observed deviation is due to array (or sampling system) drift rather than antenna monitor drift. **PI** factory tests have shown, and field experience has confirmed, that the 1900 Series monitors are extremely stable instruments that are properly suited to critical array monitoring applications. We believe, therefore, that there is little or no reason to continue to require that a monitor for a tight-tolerance directional antenna array be equipped with deviation circuits designed to accommodate a more primitive technology. Implicit in this statement is the belief that critical array monitors should, only as necessary, be replaced with **PI** 1900 Series monitors or demonstratively equivalent instruments. We specifically do not intend to imply that our AM-19D Series antenna monitors are suited to critical array

applications without an accompanying PMA-19 adapter. A comparison of the technical specifications of the PM-19 System and the 1900 series Antenna Monitors is attached to these comments as Appendix A.

VI. Conclusion

35. In its response to this *Notice*, **PI** has attempted to provide objective insight from the perspective of an equipment manufacturer who has been deeply involved with the process of quantifying AM directional antenna operating parameters for many years. In our comments, we have addressed only those matters that we feel qualified to comment upon. We are hopeful and optimistic that new computer antenna array modeling will be permitted to find its appropriate niche in the regulatory environment and that the Commission will accommodate respondents' requests for additional time to develop a consensus regarding the specifics under which this might occur. We concur with the Commission's proposed relaxation of the number of measurement points associated with both full and partial proofs of performance. In response to the Commission's request, we have suggested an electronic data interchange record format. We have explained that monitoring points are vital to the DA quality assurance process and should be retained. We have examined the compatibility of DA voltage sampling devices and current antenna monitor technology. We have provided a lengthy discussion relating to the design, manufacture and support of antenna monitors by comparing previous generation technology with current technology. And, we have voiced our reasons and expressed our strong objection to the elimination of rules establishing minimum operating standards for DA antenna monitors.

Appendix A – PI Precision Antenna Monitor Comparison Chart

	PM-19 System	1900 Series
	540 kHz to 1600 kHz	540 kHz to 1700 kHz
Frequency Range	5 digit LED Numeric (4 visible digits)	4 digit LED Numeric
Meter Type, Phase, Ratio	0º to 180º, Leading or Lagging Angles	0º to ±180º
Phase Range	± 1.0º	±1.0º (for Ratios from 0.2 to 1.999)
Phase Accuracy	0.1º	0.1º
Phase Resolution	0.3º	0.3º
Phase Repeatability	5.0% to 199.9%	0 to 1.999
Ratio Range	1.0% (20% to 110%), 2.0% (110% to 190%)	±0.0002 (for Ratios from 0.2 to 1.500)
Ratio Accuracy		(-0.006 typical @ 1.999)
	0.1%	0.001
Ratio Resolution	0.4% (20% to 190%)	0.001
Ratio Repeatability	N/A	0-1999 (scale factor & decimal set by user)
Amplitude Range	N/A	±2.0% (relative to scale factor source)
Amplitude Accuracy	0.0 to ±25.0% with polarity indication	N/A
Deviation Range	0.1%	N/A
Deviation Resolution	50 or 72 ohms	50 or 72 ohms
R.F. Input Impedance	0.5 to 20V RMS	0.3 V to 25 V RMS
R.F. Input Level Range	2.0V minimum for 100% reference	1.5 V minimum for 100% reference
Reference Tower Input Level	UHF Female (SO-239)	UHF Female (SO-239)
R.F. Input Connector	2 to 12	2 to 12
Number of Towers	1 to 3	1 to 3
Number of Patterns		
Telemetry Outputs:	0 to 5V DC for 0 to 180º, adjustable	0 to ±2.25V DC for 0 to + 180º (*)
Phase	0 to 5V DC for 0 to full scale, adjustable	0 to ±2.25V DC for 0 to 1999 (*)
Ratio	0 to ±5 V DC for 0 to 25%	N/A
Current Deviation	N/A	0 to 1999 (*)
Amplitude	50ºF to 104ºF, 0 to 95% RH	50ºF to 104ºF, 0 to 95% RH
Operating Environment	19" Rack, 14" High, 15.75" Deep	19" Rack, 51/4" High, 14" Deep
Dimensions	105 to 130V AC, 60 Hz 80 VA	117/230V AC ±10%, 50-60 Hz, 50 VA max. 30
Line Input Power	40 lbs. (approx.)	26 lbs. (approx.)
Weight	Authorized by station license	IJ3PI1900
FCC Equipment Authorization		

(*) Separate output for each tower